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Description of a New Clariid Catfish, *Clarias pseudonieuhofii* from West Borneo (Siluriformes: Clariidae)

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Sudarto, Guy G. Teugels and Laurent Pouyaud (2004) Description of a new clariid catfish, *Clarias pseudonieuhofii* from west Borneo (Siluriformes: Clariidae). *Zoological Studies* **43**(1): 8-19. *Clarias pseudonieuhofii* sp. nov. is described from the Kapuas River in Western Borneo. Morphologically, the new species differs from all other Southeast Asian *Clarias* species (excepting *C. nieuhofii*) by an anguilliform body with a short and narrow head (head length 18.5%-21.1% standard length (SL); head width 12.7%-14.3% SL). *Clarias pseudonieuhofii* differs from *C. nieuhofii* by a shorter anal fin (anal fin length 56.0%-58.9% vs. 59.7%-66.8% SL), a longer pelvic fin (pelvic fin length 6.4%-7.5% vs. 3.8%-6.3% SL), and a shorter occipital process (occipital process length 4.6%-6.8% vs. 7.6%-13.8% head length). An allozyme study revealed that the locus, *PGM**, is diagnostic between *C. nieuhofii* and the new species. The lack of heterozygous genotypes of this allozymic locus in the localities of sympatry where both species were caught together indicates that they cannot interbreed; this thus constitutes indirect proof of their complete species status.
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Key words: Morphology, Allozymes, New species, *Clarias pseudonieuhofii*, *Clarias nieuhofii*.

Clariidae or walking catfishes are diagnosed by the unique structure of the suprabranchial organ, formed by extensions of the 2nd and 4th epibranchials (Teugels and Adriaens 2003). One of its genera, *Clarias* Scopoli, 1777 belongs to the most widespread taxa in the world and naturally occurs in Africa, Asia Minor, the Indian subcontinent, Southeast (SE) Asia, and southeastern East Asia (Nelson 1994). Catfishes of the genus *Clarias* are characterized by an elongated body, long dorsal and anal fins, no adipose fin, jaws bearing a band of villiform teeth and a band of villiform or granular teeth across the vomer, small eyes with a free orbital margin, upper and lateral parts of the head osseous, or covered with only a very thin skin, 4 pairs of circumorbital barbels, ventral fins 6-rayed, and only pectoral fins possessing a spine (Günther 1864). Boulenger (1901) added that the swimbladder in this genus is bilobed, disposed transversely, and partially enclosed in a bony sheath formed by the transverse process of the 4th and 5th vertebrae. The taxonomy of African species has been revised (Teugels 1986), but that of the Asian species is not yet completed. Following Ng (1999), 9 species were recognized as valid in SE Asia (including Thailand, Vietnam, Cambodia, Malaysia, the Philippines, and Indonesia): *Clarias anfractus* Ng, 1999; *C. batrachus* (Linnaeus, 1758); *C. batu* Lim & Ng, 1999; *C. leiacanthus* Bleeker, 1851; *C. macrocephalus* Günther, 1864; *C. meladerma* Bleeker, 1846; *C. nieuhofii* Valenciennes, in Cuvier & Valenciennes, 1840; *C. olivaceus* (Fowler, 1904); and *C. planiceps* (Ng, 1999). This author

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did not include *C. fuscus* (Lacépède, 1803), a Chinese taxon with only 1 record from the Philippines (Fowler 1941) probably based on a misidentification and 1 record from Sumatra (MNHN A-8939) following Valenciennes (1840) but presently identified as a specimen of *C. leiacanthus*. Nevertheless, we propose to consider that this species belongs to the SE Asian *Clarias* as it also occurs in northern Vietnam. Two new species, namely *C. microstomus* Ng, 2001 and *C. intermedius* Teugels et al., 2001, were recently described, thus increasing the number of *Clarias* species in SE Asia to 12.

While conducting an ichthyological survey on the upper reaches of the Kapuas River in western Borneo, several specimens that we originally identified as *C. nieuhofii* were collected. *Clarias nieuhofii* is easily recognized from its congeners by its extremely elongated body with a short and narrow head, a slender caudal peduncle, and a long anal fin. However, closer morphological examination of part of the material collected in the Danau Sentarum Reserve revealed the presence of 2 distinct species. An allozymic study confirmed their reproductive isolation in sympatry (at the localities of Semitau and Meliau). Comparison of this material with the type specimens of *C. nieuhofii*, its junior synonyms of *C. gilli* Smith & Seale, 1906 and *C. pentapterus* Bleeker, 1851, and all other nominal species of SE Asian *Clarias* revealed the existence of a species new to science, herein described as *C. pseudonieuhofii* sp. nov. A redescription of *C. nieuhofii* is also given.

MATERIALS AND METHODS

Morphology

Eleven specimens representing the new species were examined. They were deposited in the Museum Zoologicum Bogoriense, Cibinong (Indonesia) (MZB), in the Zoological Reference Collection, Singapore, in the Muséum National d'Histoire Naturelle, Paris (France), and in the Musée Royal de l'Afrique Centrale, Tervuren (Belgium) (MRAC).

Comparative materials consisted of the available type specimens of all valid species of *Clarias* from SE Asia. It includes the holotype (ZRC 42598) and 2 paratypes (ZRC 43392) of *C. anfractus*; the holotype (ZRC 40087) and 7 paratypes (ZRC 40088) of *C. batu*; the holotype (BMNH 1863.12.4.55) of *C. leiacanthus* and its junior synonyms (cf. Ng, 1999) with the holotype (RMNH 6803) of *C. teijsmanni* Bleeker, 1857, the holotype (ANSP 64862) of *C. cataractus* Fowler, 1939, the holotype (RMNH 7542) of *C. pulcher* Popta, 1904, and 3 syntypes (ZMB 20944-20931) of *C. thienemanni* Ahl, 1934; the lectotype (BMNH 1862. 11.1.216) and the paralectotype (BMNH 1862.11. 1.217) of *C. macrocephalus* (see Teugels et al. 1999), the holotype (MZB 10574) and 18 paratypes (ZRC 46110-113, MNHN 2000-1212-1213, MNHN 2000-1214-1219, MRAC 96-050-P-120 and 121, MRAC 96-050-P-129-132) of *C. intermedius* Teugels et al. 2001; the lectotype (RMNH 13709) and 2 paralectotypes (BMNH 1862.2.4.8 and BMNH 1880.4.21.201) of *C. meladerma*; the syntype (RMNH 16413) of *C. melasoma* Bleeker, 1852, a junior synonym of *C. meladerma* (cf. Teugels et al. 2001); the holotype (ANSP 27280) and 3 paratypes (ANSP 27281) of *C. olivaceus*; the holotype (MNHN B300) of *C. nieuhofii*; the holotype (USNM 55620) of *C. gilli* Smith & Seale, 1906, a junior synonym of *C. nieuhofii* (cf. Bleeker 1858, Weber and de Beaufort 1913, Fowler 1941); and the holotype (SMK uncat.) and 5 paratypes (ZRC 42543, 45544, 37800, 37809, and 37820) of *C. planiceps*. It was not possible to study the type material of *C. fuscus* and *C. batrachus* with its junior synonyms *C. punctatus* and *C. jagur* because the type specimens are lost. Following Teugels and Roberts (1987), the specimen (NRM 71) deposited in the Naturhistoriska Riksmuseet in Stockholm cannot be the holotype of *Silurus batrachus* but corresponds to a type specimen of *C. anguillaris* (Linné, 1758). We therefore studied the 2 syntypes (BMNH 1858. 8.15.101 and 102) of *Clarias* (= *Macropteronotus*) *magur* (Hamilton, 1822) and 2 syntypes (MNHN B685) of *C. marpus* Valenciennes (in Cuvier and Valenciennes 1840), and 2 junior synonyms of *C. batrachus* following Bleeker (1858) and Günther (1864).

Additional materials examined included around 500 *Clarias* specimens conspecific with all valid species from SE Asia and housed in different natural history museums. It also included specimens from the type localities of *C. punctatus*, *C. fuscus*, *C. microstomus*, and *C. pentapterus* (a junior synonym of *C. nieuhofii*; Fowler 1941). The list of specimens examined can be requested at the address of the senior author.

On each specimen, 29 measurements were taken using dial calipers. They included total length (TL), standard length (SL), maximal body depth at anus (MBD), caudal peduncle depth

(CPD), head length (HL), head width (HW), snout length (SNL), interorbital width (IOW), eye diameter (ED); nasal barbel length (NBL), maxillary barbel length (MBL), inner mandibular barbel length (IMBL), outer mandibular barbel length (OMBL), occipital process length (OPL), occipital process width (OPW), frontal fontanelle length (FFL), frontal fontanelle width (FFW), premaxillary toothplate width (PMW), vomerine toothplate width (VMW), predorsal length (PDL), preanal length (PAL), prepelvic length (PPL), prepectoral length (PPEL), dorsal fin length (DFL), length between occipital process and dorsal fin base (OPDF), pectoral spine length (PESL), pectoral fin length (PEFL), pelvic fin length (PFL), and anal fin length (AFL). Measurements follow Teugels et al. (1999). The following meristic counts were made: number of gill rakers on the 1st branchial arch, number of dorsal fin rays, number of anal fin rays, and the roughness of the anterior side of the pectoral spine (presence or absence of serrations). Special morphological observations include the shape of the occipital process, the shape of the frontal fontanelle, the shape of the pectoral spine, the position of the secondary openings of the lateral line system, the positions of the dorsal, caudal and anal fins, and the coloration.

Genetics

Enzymatic polymorphism was screened in 21 specimens of the new species and in 106 specimens of *C. nieuhofii* in order to determine the putative existence of diagnostic loci between those species and to test their reproductive isolation in sympatry. The geographic origin and size of the samples examined for allozymes are given in table 1. The allozyme analysis (tissue extraction, migration buffers, and staining procedure) was conducted using standard methods of horizontal starch gel electrophoresis following the procedure described by Guyomard and Krieg (1983), Krieg and Guyomard (1985), and Pouyaud and Agnèse (1995). The resulting zymograms were scored for variations at 18 loci. Table 2 shows the enzyme systems and the buffers used as well as the source tissues in which the different loci were expressed. The nomenclature is that proposed by Shaklee et al. (1990). Because of its occurrence on most Asian farms, the African clariid *C. gariepinus* (Burchell, 1822) is represented as the species of reference for allelic designation. Twenty specimens from the Central Research Institute for Aquaculture in Indonesia (CRIA) strain were studied. Alleles were designed according to their electrophoretic mobility, meaning that the most common allele in the reference species was considered to be **100*. The mean values of observed heterozygosity (H_{obs}) and non-biased heterozygosity (H_{nb}) which take into account the sample size were computed using the Genetix package (Belkhir et al. 1996).

RESULTS

Morphological comparisons between *Clarias pseudonieuhofii* sp. nov. and all valid SE Asian *Clarias* species

Clarias pseudonieuhofii and *C. nieuhofii* are characterized by an extremely elongated body and differ from all valid SE Asian *Clarias* species by higher numbers of dorsal fin rays (82-105 vs. 61-79) and anal fin rays (73-96 vs. 46-65), a shorter head length (16.7%-21.1% vs. 22.1%-30.9% SL; Fig. 1), and a shorter head width (11.7%-15.0% vs. 15.5%-21.9% SL; Fig. 1). The new species also possesses a shorter pectoral fin length (6.4%-7.5% vs. 10.7%-17.0% SL) and a shorter pectoral

Table 1. Geographic origin and sample size of the populations of *Clarias nieuhofii* and *C. pseudonieuhofii* sp. nov. analyzed with allozymes

Species	Sampling origin (river, location, country)	*n* (allozymes)
C. nieuhofii	Batanghari, Jambi, Sumatra, Indonesia	5
	Siak, Pakanbaru, Sumatra	3
	Rokam, Bangko, Sumatra	3
	Indragiri, Telukkuantan, Sumatra	3
	Indragiri, Rengat, Sumatra	4
	Indragiri, Tembilahan, Sumatra	5
	Batanghari, Muarabungo, Sumatra	3
	Musi, Palembang, Sumatra	5
	Tulangbawang, Tegineneng, Sumatra	5
	Sambas, Sambas, Kalimantan, Indonesia	6
	Sambas, Benkayang, Kalimantan	3
	Pawan, Ketapang, Kalimantan	13
	Kapuas, Sentarum, Semitau, Kalimantan	14
	Kapuas, Sentarum, Meliau, Kalimantan	10
	Kahayan, Bereng Bengkel, Kalimantan	6
	Mahakam, Samarinda, Kalimantan	3
	Berau, Tanjungredeb, Kalimantan	13
	Kayan, Tanjungselor, Kalimantan	2
C. pseudonieuhofii sp. n.	**Kapuas, Sentarum, Meliau, Kalimantan**	6
	Kapuas, Sentarum, Semitau, Kalimantan	15

spine length (5.7%-7.1% vs. 7.2%-15.3% SL) than all of its SE Asian congeners (excepting *C. nieuhofii*).

Clarias pseudonieuhofii is distinguished from *C. intermedius*, *C. macrocephalus*, *C. meladerma*, and its junior synonym *C. melasoma* by a longer distance between the tip of the occipital process and the base of the 1st dorsal fin ray (6.1%-7.6% vs. 1.2%-5.1% SL).

Finally, *C. pseudonieuhofii* has a shorter occipital process length (4.6%-6.8% vs. 6.9%-17.9% HL) and a shorter predorsal length (25.6%-27.9% vs. 29.7%-37.1% SL) than the remaining species of *C. anfractus*, *C. batu*, *C. leiacanthus* (with its junior synonyms *C. teijsmanni*, *C. cataractus*, *C. pulcher*, and *C. thienemanni*), *C. olivaceus*, *C. planiceps*, *C. batrachus* (with its junior synonyms *C. marpus*, *C. magur*, and *C. punctatus*), *C.*

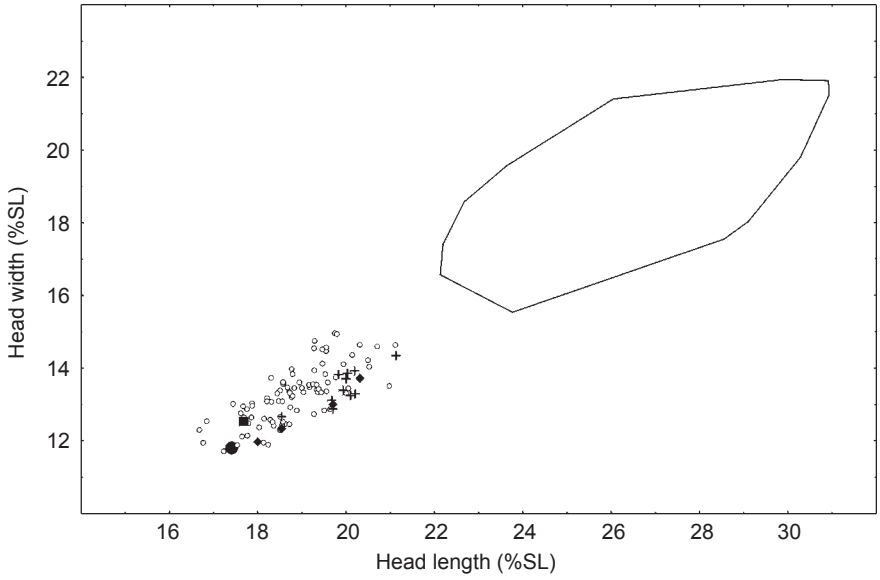

Fig. 1. Correlation between head length (% standard length) and head width (% standard length) in Asian *Clarias* specimens. ● Holotype *C. nieuhofii*; ■ holotype *C. gilli*; ◆ specimens from the type locality (Banjarmasin) of *C. pentapterus*; ○ other specimens of *C. nieuhofii*; + specimens of the new species (*C. pseudonieuhofii*).

Table 2. Enzyme systems, abbreviations, loci, tissues and electrode buffers used

Enzyme system	Abbreviation	Locus	Tissue	Electrode buffer
Alcohol dehydrogenase	ADH, E.C. 1.1.1.1	*ADH**	Liver	POULIK1/2
Adenylate kinase	AK, E.C. 2.7.4.3.	*AK**	Muscle	MC 2
Creatine kinase	CK, E.C. 2.7.3.2.	*CK**	Muscle	MC 2
6 Phosphogluconate dehydrogenase	6PGDH, E.C. 1.1.1.44.	*6PGDH**	Liver	MC 2 / POULIK1/2
Glucose-6-phosphate isomerase	GPI, E.C. 5.3.1.9	*GPI-1**	Muscle/Eyes	RW
		*GPI-2**	Muscle/Eyes	RW
Isocitrate dehydrogenase	IDHP, E.C. 1.1.1.42	*IDHP-1**	Muscle	MC 2
		*IDHP-2**	Liver	MC 2
L-Lactate dehydrogenase	LDH, E.C. 1.1.1.27	*LDH-1**	Eyes	MC 2
		*LDH-2**	Eyes	MC 2
Malate dehydrogenase	MDH, E.C. 1.1.1.37	*MDH-1**	Eyes	MC 2
		*MDH-2**	Eyes	MC 2
Mannose phosphate isomerase	MPI, E.C. 5.3.1.8	*MPI**	Liver	POULIK1/2
Phosphoglucomutase	PGM, E.C. 5.4.2.2	*PGM**	Muscle/Eyes	RW
Protein total	PT	*PT-1**	Muscle	MC 2
		*PT-2**	Muscle	MC 2
Sorbitol dehydrogenase	SDH, E.C. 1.1.1.14.	*SDH-1**	Liver	MC 2
Superoxide dismutase	SOD, E.C. 1.15.1.1	*SOD**	Liver	MC 2

Table 3. Allelic frequencies and heterozygosities for the 18 allozymic loci screened in *Clarias pseudonieuhofii* and *C. nieuhofii*

		Clarias nieuhofii (Sumatra)								
		Palembang	Tegineneng	Jambi	Muarabungo	Telukkuantan	Pakanbaru	Bangko	Tembilahan	Rengat
*IDHP-1**	070	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00
	080	0.20	0.40	0.30	0.33	0.00	0.00	0.17	0.50	0.75
	090	0.80	0.60	0.70	0.67	1.00	0.83	0.83	0.50	0.25
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*IDHP-2**	070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.10	0.00
	110	1.00	1.00	1.00	1.00	0.67	1.00	1.00	0.90	1.00
*SOD**	040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	110	0.20	0.50	1.00	1.00	1.00	0.83	0.83	0.90	1.00
	140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	150	0.70	0.50	0.00	0.00	0.00	0.17	0.17	0.10	0.00
	180	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*MPI**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*ADH**	090	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*PROT-1**	090	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*PROT-2**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	102	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*PGM**	050	0.00	0.00	0.10	0.00	0.33	0.00	0.00	0.30	0.12
	098	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	1.00	1.00	0.90	1.00	0.67	1.00	1.00	0.70	0.88
	102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*MDH-1**	020	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
	100	1.00	1.00	1.00	1.00	0.83	1.00	1.00	1.00	1.00
*MDH-2**	075	0.90	1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	102	0.10	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00
*GPI-1**	100	1.00	1.00	0.80	0.83	0.83	1.00	0.67	0.90	0.62
	180	0.00	0.00	0.20	0.00	0.17	0.00	0.00	0.00	0.25
	200	0.00	0.00	0.00	0.17	0.00	0.00	0.33	0.10	0.13
	500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*GPI-2**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	120	0.70	0.60	0.90	1.00	0.83	1.00	1.00	0.60	0.00
	140	0.30	0.40	0.10	0.00	0.17	0.00	0.00	0.40	1.00
	160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*AK**	050	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*CK**	080	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*SDH**	080	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*LDH-1**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*LDH-2**	096	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*6PGDH**	055	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_{nb}/H_{obs}		0.078/0.085	0.078/0.090	0.078/0.097	0.018/0.048	0.130/0.115	0.037/0.037	0.074/0.067	0.056/0.120	0.028/0.071

Table 3. (Cont.)

		Clarias nieuhofii (Kalimantan)								*C. pseudonieuhofii* sp. n.		*C. gariepinus*
		Ketapang	Samarinda	Bereng Bengkel	Tanjung Selor	Tanjung Redeb	Sambas	Bengkayeng	Semitau	Meliau	Semitau	Meliau	RIFF strain
*IDHP-1**	070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	090	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
*IDHP-2**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	070	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	110	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
*SOD**	040	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
	110	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	1.00	1.00	0.00
	140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
	150	1.00	1.00	0.00	1.00	0.00	0.25	1.00	1.00	1.00	0.00	0.00	0.00
	180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*MPI**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	105	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
*ADH**	090	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*PROT-1**	090	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*PROT-2**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	102	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
*PGM**	050	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	098	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.60**	**0.55**	0.00
	100	1.00	1.00	0.17	1.00	0.65	1.00	1.00	1.00	1.00	0.00	0.00	1.00
	102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.40**	**0.45**	0.00
	120	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*MDH-1**	020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*MDH-2**	075	0.96	1.00	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	102	0.04	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*GPI-1**	100	1.00	0.50	1.00	0.50	0.73	0.92	1.00	1.00	1.00	1.00	1.00	1.00
	180	0.00	0.50	0.00	0.50	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	500	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
*GPI-2**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	120	0.81	1.00	0.25	1.00	1.00	0.83	0.83	0.83	1.00	1.00	1.00	0.00
	140	0.19	0.00	0.67	0.00	0.00	0.17	0.17	0.17	0.00	0.00	0.00	0.00
	160	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*AK**	050	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*CK**	080	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*SDH**	080	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*LDH-1**	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
*LDH-2**	096	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
*6PGDH**	055	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
H_{nb}/H_{obs}		0.026/0.031	0.056/0.033	0.056/0.056	0.056/0.037	0.034/0.049	0.056/0.049	0.018/0.018	0.020/0.020	0.00/0.00	0.056/0.056	0.056/0.056	0.056/0.056

fuscus, and *C. microstomus*.

Morphological differences between *Clarias pseudonieuhofii* sp. nov. and *C. nieuhofii*

Clarias nieuhofii was first described by Valenciennes (1840). Two other nominal species, *C. gilli* Smith & Seale, 1906 and *C. pentapterus* Bleeker, 1851 were considered junior synonyms of *C. nieuhofii*. We measured the holotype of *C. gilli* (originating from the Philippines) and specimens from the type locality of *C. pentapterus* (Banjarmasin, Kalimantan) as its holotype is lost. Our results confirm the synonymies of *C. gilli* and *C. pentapterus* with *C. nieuhofii* because not a single character enables their differentiation.

As stated above, the new species presents many morphological similarities with the anguilliform of *C. nieuhofii*. Nevertheless, the new species can be easily distinguished from *C. nieuhofii* and its junior synonyms by longer pelvic fins (6.4%-7.5% vs. 3.8%-6.3% SL; Fig. 2), a shorter anal fin (56.0%-58.9% vs. 59.7%-66.8% SL), and a shorter occipital process length (4.6%-6.8% vs. 7.6%-13.8% HL).

Allozyme data

Analysis of the zymograms performed on the new species and *C. nieuhofii* showed polymorphism at the loci studied with a total of 37 alleles (1.2 alleles/locus/population). Allelic frequencies and rates of non-biased (H_{nb}) and observed heterozygosities (H_{obs}) are given in table 3. Within *C. nieuhofii*, populations from Sumatra were ranked between 0.037 and 0.120 and populations from Kalimantan between 0.000 and 0.056. Within *C. pseudonieuhofii*, both studied populations displayed a value of 0.056. Considering the entire allozymic variability estimated respectively for *C. nieuhofii* and *C. pseudonieuhofii*, we can assume that the locus *PGM** is diagnostic. *Clarias nieuhofii* is characterized by alleles *PGM*050*, *PGM*100*, and *PGM*120*, while *C. pseudonieuhofii* only possesses alleles *PGM*098* and *PGM*102* at equivalent frequencies. The new species *C. pseudonieuhofii* occurs sympatrically with *C. nieuhofii* at the localities of Semitau and Meliau in the flooded forest area bordering Sentarum Lake (upper Kapuas drainage, West Kalimantan, Borneo, Indonesia). The lack of heterozygous genotypes of the allozymic locus, *PGM**, between those species in sympatry is also indirect proof of

Fig. 3. Lateral view of *Clarias pseudonieuhofii* sp. nov., holotype.

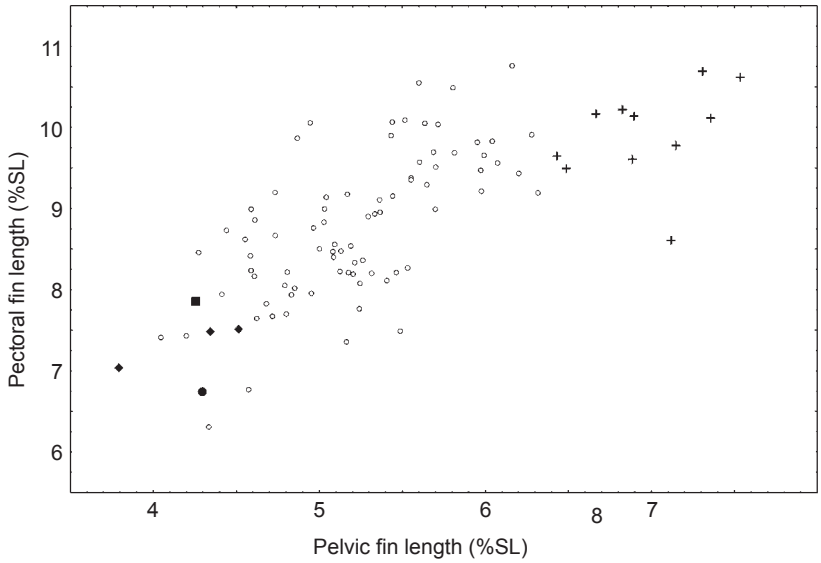

Fig. 2. Correlation between pelvic fin length (% SL) and pectoral fin length. ● Holotype of *Clarias nieuhofii*; ○ other specimens of *C. nieuhofii*; ■holotype *C. gilli*; ◆ specimens from the type locality (Banjarmasin) of *C. pentapterus*; + specimens of the new species (*C. pseudonieuhofii*).

their complete species status with the existence of reproductive isolation.

The description of the new species is followed by a redescription of *C. nieuhofii*.

***Clarias pseudonieuhofii* sp. nov.**

(Fig. 3)

Material examined: *Holotype*: MZB 10966, 311 mm SL, Semitau, near the Danau Sentarum Reserve, upstream Kapuas R., on the road between Sintang and Putussibau, West Kalimantan, Borneo, Indonesia, coll. Sudarto and L. Pouyaud, Mar. 2000.

Paratypes: ZRC 47411 (4 specimens) and MNHN 2002-3389 (4 specimens), 230-316 mm SL, same data as for holotype; MNHN 2002-3390 (1 specimen) and MRAC A3-07-P-1 (1 specimen), 290-316 mm SL, Meliau, in the Danau Sentarum Reserve, West Kalimantan, Borneo, Indonesia, coll. Sudarto and L. Pouyaud, Mar. 2000.

Diagnosis: *Clarias pseudonieuhofii* differs from all other SE Asian *Clarias* species except *C. nieuhofii* by an anguilliform body with a short (HL, 18.5%-21.1% SL) and narrow (HW, 12.7%-14.3% SL) head. *Clarias pseudonieuhofii* differs from *C. nieuhofii* by a shorter anal fin (AFL, 56.0%-58.9% vs. 59.7%-66.8% SL), a longer pelvic fin (PFL, 6.4%-7.5% vs. 3.8%-6.3% SL), and a shorter occipital process (OPL, 4.6%-6.8% vs. 7.6%-13.8% HL).

Description: Description is based on the holotype and 10 paratypes. Measurements are given in table 4.

Head small and narrow; viewed dorsally, with oval to rectangular outline. Eyes small, laterally placed. Occipital process more or less angular and very short, its length varying between 4.6% and 6.8% of HL. Occipital fontanelle distantly set from occipital process. Frontal fontanelle about twice as long as wide. Premaxillary toothplate width the same as that of vomerine toothplate.

Table 4. Measurements taken on the holotype and paratypes of *Clarias pseudonieuhofii* sp. nov.

Variable	Specimens examined				
	n	Min	Max	Mean	SD
Standard length (mm)	11	230	316		
In % standard length					
Maximal body depth	11	11.0	12.9	11.9	0.6
Caudal peduncle depth	11	3.6	6.3	4.8	0.7
Head length	11	18.5	21.1	19.9	0.6
Predorsal length	11	25.6	27.9	26.6	0.7
Preanal length	11	39.0	43.2	40.7	1.2
Prepelvic length	11	35.2	38.9	36.7	1.2
Prepectoral length	11	15.0	16.9	15.8	0.5
Dorsal fin length	11	70.9	74.3	72.4	1.0
Length between occipital process and dorsal fin	11	6.1	7.6	6.9	0.5
Pectoral spine length	11	5.7	7.1	6.4	0.4
Pectoral fin length	11	8.6	10.7	9.9	0.6
Pelvic fin length	11	6.4	7.5	7.0	0.4
Anal fin length	11	56.0	58.9	57.7	0.9
Head width	11	12.7	14.3	13.5	0.5
In % head length					
Snout length	11	21.7	23.9	22.6	0.8
Interorbital width	11	38.7	43.2	40.6	1.2
Eye diameter	11	4.7	6.7	5.7	0.6
Occipital process length	11	4.6	6.8	5.8	0.8
Occipital process width	11	24.0	35.2	27.4	3.3
Frontal fontanelle length	11	9.8	15.4	12.5	1.8
Frontal fontanelle width	11	5.0	9.2	7.1	1.3
Premaxillary toothplate width	11	20.2	25.0	23.0	1.3
Vomerine toothplate width	11	20.4	25.0	22.3	1.4

Table 5. Measurements taken on the holotype and 97 specimens of *Clarias nieuhofii*

Variable	Specimens examined				
	n	Min	Max	Mean	SD
Total length (mm)	83	185	447		
Standard length (mm)	95	163	405		
In % standard length					
Maximal body depth	95	9.7	14.3	11.9	0.9
Caudal peduncle depth	94	3.3	5.7	4.5	0.5
Head length	94	16.7	21.1	18.8	0.9
Predorsal length	92	22.2	29.6	25.2	1.4
Preanal length	93	34.0	42.2	38.5	1.8
Prepelvic length	92	30.9	39.0	35.0	1.7
Prepectoral length	89	13.0	16.3	14.8	0.8
Dorsal fin length	27	72.3	80.1	75.8	2.0
Length between dorsal and caudal fin	25	- 2.8	3.9	- 0.1	1.8
Length between occipital process and dorsal fin	93	4.7	9.4	6.7	1.0
Pectoral spine length	91	3.8	7.7	6.0	0.7
Pectoral fin length	91	6.3	10.8	8.7	0.9
Pelvic fin length	87	3.8	6.3	5.2	0.6
Anal fin length	27	59.7	66.8	62.6	1.7
Head width	94	11.7	15.0	13.2	0.8
In % head length					
Snout length	96	19.3	26.7	22.9	1.7
Interorbital width	95	37.6	45.5	41.4	1.8
Eye diameter	98	4.6	7.4	6.0	0.6
Occipital process length	96	7.6	13.8	10.9	1.5
Occipital process width	95	25.0	33.5	29.3	1.7
Frontal fontanelle length	97	7.9	18.7	12.8	2.1
Frontal fontanelle width	96	3.9	9.4	6.7	1.2
Premaxillary toothplate width	98	20.7	29.9	25.0	1.6
Vomerine toothplate width	98	20.1	27.1	22.6	1.3

Maxillary barbels reaching level of dorsal fin origin. Nasal barbels almost reaching level of pectoral spine base. Outer mandibular barbels about as long as head. Inner mandibular barbels about 1/2 HL.

Body anguilliform as shown by small body depth at anus and shallow caudal peduncle. Pelvic fin as well as pectoral fin and spine relatively short compared to other Asian *Clarias* species. Nevertheless, pelvic fins of *C. pseudonieuhofii* longer than those of *C. nieuhofii*. Pectoral spine serrated on its outer side (24 small serrations in holotype), while inner side with a few, upwardly pointed serrations (12 in holotype). Pectoral fin not reaching level of dorsal fin origin. Pelvic fin reaching anal fin base. Dorsal, caudal, and anal fins not confluent. Lateral line appearing as discrete white line running from posterolateral end of head to middle of caudal fin base. Above lateral line with 12-15 transverse rows of small white spots, sometimes difficult to observe. Below line with relatively numerous small spots in irregular longitudinal band.

Number of dorsal fin rays varying between 87 and 90 (90 in holotype); anal fin rays ranging between 73 and 81 (77 in holotype).

Coloration: In living specimens, the skin is dark brown to black. Color is deeper on the dorsal surface of the body and the paired fins. The ventral surface is light brown.

Distribution: *Clarias pseudonieuhofii* is presently only known from the upper basin of the Kapuas R. in West Kalimantan, in a geographic area bordering Sentarum Lake (Fig. 4).

Clarias nieuhofii Valenciennes, 1840
(Fig. 5)

Prophagorus nieuhofii (Fowler, 1905): Proc. Acad. Nat. Sci. Philadelphia, p. 461
Clarias pentapterus Bleeker, 1851: Nat. Tijdschr. Nederland. Indie 2: 206
Clarias gilli Smith and Seale, 1906: Proc. Biol. Soc. Washington, 19: 74

Material examined: Holotype: MNHN B.300/ 96.15.1.1, 405 mm SL, Inde.

Other specimens examined: USNM 55620, holotype of *C. gilli*, 289 mm SL, Rio Grande, Mindanao, the Philippines; CAS 95128, 163 mm SL, Menam Bang Nara Basin, Khlong Ko about 7 km SW of Tak Bai, Changwai, Naratiwat, Thailand,

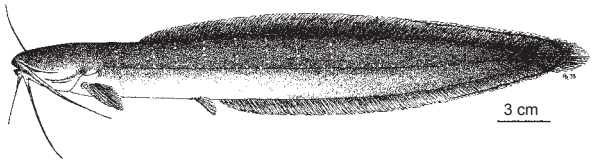

Fig. 5. Lateral view of a specimen from *C. nieuhofii*, 325 mm total length, from the Batang Hari River at Jambi, Sumatra.

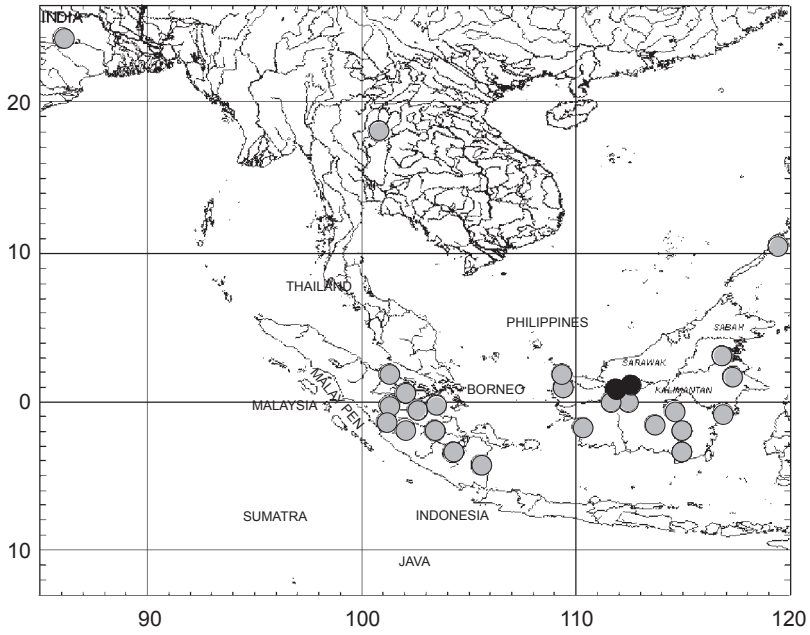

Fig. 4. Natural distribution of *Clarias pseudonieuhofii* sp. nov. (●) and *C. nieuhofii* (●).

coll. T. Roberts, Mar. 1989; CAS 95129, 179 mm SL, Sungai Golok Basin, peat swamp forest 12 km SW of Tak Bai, Thailand, coll. T. Roberts, Mar. 1989; MNHN 2003-0292, 4 specimens, 223-290 mm SL, from Banjarmasin (the type locality of *C. pentapterus* from where all types are lost), South Kalimantan, Borneo, Indonesia, coll. A. Pariselle and A. Kristanto, 1997; MNHN 2003-0293, 4 specimens, 300-390 mm SL, Palangkaraya, Central Kalimantan, Borneo, Indonesia, coll. A. Pariselle and A. Kristanto, 1997; MNHN 2003-0294, 4 specimens, 232-282 mm SL, Muara Teweh, Central Kalimantan, Borneo, Indonesia, coll. A. Pariselle and A. Kristanto, 1997; MNHN 2003-0295, 3 specimens, 286-362 mm SL, Samarinda, East Kalimantan, Borneo, Indonesia, coll. A. Pariselle and A. Kristanto, 1997; MNHN 2003-0296, 20 specimens, 193-359 mm SL, Tegineneng, South Sumatra, Indonesia, coll. M. Legendre, Sudarto, O. Komarudin, and L. Pouyaud, Feb. 1997; MNHN 2003-0297, 16 specimens, 235-334 mm SL, Palembang, South Sumatra, Indonesia, coll. M. Legendre, Sudarto, O. Komarudin, and L. Pouyaud, Feb. 1997; MNHN 2003-0298, 9 specimens, 258-328 mm SL, Jambi, Sumatra, Indonesia, coll. M. Legendre, Sudarto, O. Komarudin, and L. Pouyaud, Feb. 1997; MNHN 2003-0299, 1 specimen, 387 mm SL, Telukkuantan, Sumatra, Indonesia, coll. L. Pouyaud and Sudarto, May 1997; MNHN 2003-0300, 7 specimens, 178-373 mm SL, Pekambaru, North Sumatra, Indonesia, coll. L. Pouyaud and Sudarto, May 1997; MNHN 2003-0301, 10 specimens, 248-397 mm SL, Bangko, Rokam Basin, North Sumatra, Indonesia, coll. L. Pouyaud and Sudarto, May 1997; MNHN 2003-0302, 9 specimens, 197-354 mm SL, Rimbobujang, Sumatra, Indonesia, coll. L. Pouyaud and Sudarto, May 1997; MNHN 2003-0303, 3 specimens, 223-262 mm SL, Muara Bungo, Sumatra, Indonesia, coll. L. Pouyaud and Sudarto, May 1997; MNHN 2003-0304, 2 specimens, 237-275 mm SL, Tembilahan, coll. Sudarto, July 2000; MNHN 2003-0305, 2 specimens, 283 and 300 mm SL, Semitau, near Santarum Lake, West Kalimantan, Borneo, Indonesia, coll. Sudarto and L. Pouyaud, Mar. 2000; MNHN 2003-0306, 2 specimens, 200 and 205 mm SL, Nanga Pinoh, R. Melawi, West Kalimantan, Borneo, Indonesia, coll. Sudarto and L. Pouyaud, Mar. 2000.

Diagnosis: *Clarias nieuhofii* is distinguished from all other Asian *Clarias* species by the combination of the following characters: anguilliform body with a short (HL, 16.7%-21.1% SL) and narrow (HW, 11.7%-15.0% SL) head, very short pelvic fin (PFL, 3.8%-6.3% SL), and long anal fin (AFL, 59.7%-66.8% SL).

Description: The description is based on the holotype of *C. nieuhofii*, the holotype of its junior synonym *C. gilli* and 98 other specimens examined (including 4 specimens from the type locality of *C. pentapterus*) (Table 5).

Head small, narrow; viewed dorsally, with an oval to rectangular outline. Occipital process quite angular; its length varying between 7.6% and 13.8% of HL. Frontal fontanelle about twice as long as wide. Premaxillary toothplate slightly longer than vomerine toothplate. Maxillary barbels almost reaching level of dorsal fin origin. Nasal barbels reaching level of pectoral spine base. Outer mandibular barbels about as long as head. Inner mandibular barbels about 1/2 HL.

Body anguilliform as shown by small body depth at anus and shallow caudal peduncle. Pelvic fin, pectoral fin, and spine relatively short. Pelvic fin shorter than that in *C. pseudonieuhofii*. Pectoral fin not reaching level of dorsal fin origin. Pelvic fin reaching anal fin base until basis of 2nd ray. Pectoral spine with numerous (20-25) small serrations on outer side and a few upwardly pointed serrations present on inner side. Dorsal, caudal, and anal fins not confluent. Anal fin longer than that in *C. pseudonieuhofii*. Lateral line appearing as a small white line running from posterolateral end of head to middle of caudal fin base. Above lateral line with 15-20 transverse rows of white or yellow spots. Below line with relatively larger spots in irregular longitudinal band. In some specimens, these white spots only well marked on anterior 1/3 of body.

Number of gill rakers on 1st branchial arch varying between 15 and 24; number of dorsal fin rays varying between 82 and 105; number of anal fin rays ranging between 73 and 96; total number of vertebrae ranging between 67 and 79.

Coloration: In living specimens, color from light gray to dark brown. In preserved specimens, color from light brown to black. Both in life and in preserved specimens, color deeper on dorsal surface of body and paired fins. Ventral surface creamy. In specimens with dark brown to black coloration, white or yellowish spots formed by secondary openings of lateral line system clearly visi-

ble.

Distribution: *Clarias nieuhofii* has been reported from North Borneo (Inger and Chin 1962), Thailand, the Malay Archipelago (Menon 1951), Sumatra, Java, Borneo, rarely in Thailand (Smith 1934), British Malaya, East Indies, Thailand, and the Philippines (Fowler 1941). Specimens examined in the present study (including the type specimens) originated from Indonesia (Sumatra and Kalimantan), India, Thailand, and the Philippines (Fig. 4).

CONCLUSIONS

The diversity of inland fishes in SE Asia is very high, with about 1000 species known from western Indonesia and some 900 known from mainland SE Asia (Kottelat 1998). Kottelat et al. (1993) indicated that Borneo displays the highest rate of endemicity for many freshwater families. In Borneo, catfishes constitute, together with the cyprinids, the most abundant component of the freshwater fish fauna, and they also tend to display an overwhelming rate of endemic species. This is particularly true for the Pangasiidae, with 7 endemic species (Roberts 1989, Roberts and Vidthayanon 1991, Pouyaud and Teugels 2000, Pouyaud et al. 2002, Gustiano et al. 2003). Member of the Clariidae also display a considerable richness of species endemic to Borneo as shown by the recent description of 3 new species from the northern and eastern parts of the island by Ng (1999 2001) and 1 from the central region by Teugels et al. (2001). The present description of *Clarias pseudonieuhofii* sp. nov. confirms that the diversity of SE Asian clariids is largely underestimated, in particular on the Island of Borneo which exhibits numerous river drainages isolated from each other by hilly landscape or marine waters.

Some authors suspected that the widespread *C. nieuhofii* was composed of several distinct species (cf. *C. pentapterus* and *C. gilli*), but others subsequently demonstrated their synonymy with *C. nieuhofii*. Until now and especially in SE Asia, few species descriptions have involved a combination of morphometric and genetic analyses. In our opinion, such combined methodological approaches are essential as genetic data can demonstrate reproductive isolation between 2 sympatric taxa and can also validate any diagnostic morphologic character. This is particularly true for *C. pseudonieuhofii* sp. nov., a species morphologically close to *C. nieuhofii* and only differing from the former by a shorter anal fin, a shorter occipital process, and longer pelvic fins.

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